

the coking of the fuel has not entirely removed the nitrogen which was present in the coal. It also seems that, when nitrogen has once entered pig-iron in the blast-furnace, it cannot be removed by subsequent heating. It seems desirable to ascertain more definitely by further experiments how titanium acts in practice in the removal of nitrogen from steel.

A very important paper was presented by the Hon. C. A. Parsons on the application of the marine steam turbine and mechanical gearing to merchant ships. The steam turbine has not hitherto been applied to vessels of slow normal speed on account of the high initial cost and inferior economy in steam. No promising scheme has, as yet, been evolved whereby the efficient speed of the turbine may be reduced and that of the propeller increased for vessels of 12 knots sea speed and under. The only approach of meeting these conditions has been in the combination system of reciprocating engines and turbines, in which the lower stages of the expansion are effected in the turbines.

Provided the losses in transmission, first cost, and cost of maintenance are not too great, the most satisfactory solution for slow-speed vessels would appear to be by means of gearing. Mechanical, electrical, and hydraulic gearing have been proposed or applied, and the author proceeded to give an account of his successful experiments in developing a mechanical gearing.

Helical and double helical gear wheels of fine pitch were probably first introduced by De Laval in connection with his turbine, and have proved to be very satisfactory and efficient. Mr. Parsons has had several sets made. One of these, made in 1897, gearing from 9600 revolutions of the turbine to 4800 of the dynamo, transmitted 300 horsepower with an efficiency of more than 98 per cent. This gear ran fourteen hours a day for about a year. Recent and better cut gears have given a total loss in the gear-case of 1.5 per cent., including friction of gear and bearings.

The author was thus led to experiment with a view to obtain comparative figures for a cargo vessel, first fitted with ordinary reciprocating engines, and then with turbines and mechanical gearing of the above-mentioned type. The *Vespasian* was purchased for this purpose. Her dimensions are:—length on load water-line, 275 feet; breadth moulded, 38 feet 9 inches; depth moulded, 21 feet 2 inches; mean loaded draught, 19 feet 8 inches; displacement, 4350 tons. The vessel was first fitted with triple-expansion surface-condensing engines of ordinary pattern, cylinders 22 $\frac{1}{4}$ inches by 35 inches by 59 inches, and 42-inch stroke. There were two boilers, each 13 feet in diameter and 10 feet 6 inches long, of total heating surface 3430 square feet, and grate area of 98 square feet. The working pressure was 150 lb. per square inch. A four-bladed cast-iron propeller was fitted, having a diameter of 14 feet, pitch 16.35 feet, and expanded area of 70 square feet.

Before proceeding on the experimental voyage from the Tyne to Malta, the reciprocating propelling machinery was completely dismantled and overhauled. The machinery was thus brought into an efficient and first-class working order. Suitable tanks were provided for measuring the steam consumption. Loaded with a cargo of coal, the *Vespasian* left the Tyne on June 26, 1909, and careful measurements of coal and water consumption were made throughout the voyage by a special recording staff.

On the completion of this voyage the vessel returned to the turbine works, the reciprocating engines were removed, and turbines and gearing fitted. The importance of these trials lies in the fact that the only alteration made in the vessel was in the type of propelling engines. Boilers, propeller, shafting, and thrust blocks remained the same as for the reciprocating engine.

The turbine machinery consisted of two turbines in series, one high-pressure and one low-pressure, the high-pressure turbine being on the starboard side of the vessel and the low-pressure on the port side. At the after end of each turbine a driving pinion is connected, having a flexible coupling between the pinion shaft and the turbine, the pinion on each side of the vessel being geared into a wheel which is coupled to the propeller shaft. A reversing turbine is incorporated in the exhaust casing of the low-pressure turbine. The usual air, circulating, feed, and bilge pumps are driven from the forward end of the gear-wheel shaft. The turbine and pinion shaft bearings are

under forced lubrication; the teeth of the gear wheels are lubricated by means of a spray pipe extending over the whole width of the wheel face.

The high-pressure turbine is 3 feet maximum diameter by 13 feet over-all length, and the low-pressure 3 feet 10 inches in diameter by 12 feet 6 inches in length. The turbines were balanced for steam thrust only, the propeller thrust being taken up by a thrust block. A new condenser with a vacuum augmentor was fitted. The gear wheel is cast iron with two forged steel rims shrunk on. This wheel is 8 feet 3 $\frac{1}{2}$ inches in diameter of pitch circle, and has 398 double helical teeth of circular pitch 0.7854 inch. The total width of face of wheel is 24 inches; the teeth have an inclination of 20° to the axis. The pinion shafts are of chrome nickel steel, 5 inches diameter of pitch circle, with twenty teeth of 0.7854 circular pitch. The ratio of the gear is 19.9 to 1.

On completion of the alterations, at the end of February of this year, the vessel was loaded to the same draught and displacement as that recorded for progressive trials on the Hartley mile with reciprocating engines. In the short interval since the completion of the alterations the vessel has been out to sea on four occasions.

Mr. Parsons gives full information and curves showing the results of the trials. We abstract the following important figures from these.

Water Consumption per Hour, for all Purposes.

Revolutions of propeller vessel, knots	Speed of Reciprocating engines	Lbs. of water per hour		Saving, per cent.
		Turbines		
60	8.87	11,750	10,750	8.5
65	9.55	14,500	12,600	13
70	10.2	17,500	14,750	16

The turbines and gearing have given no trouble, and have worked satisfactorily, with very little noise or vibration, throughout the trials. There is no appreciable wear on the teeth or bearings. It is proposed to put the vessel into commission and run extended trials. Mr. Parsons further added that the saving in weight on installing the turbines amounted to 25 per cent.

Speakers in the discussion were unanimous in commending Mr. Parsons for his success, which is likely to revolutionise the means of propulsion of tramp steamers, which, as Sir William White remarked, form the backbone of mercantile business. Prof. Ewing pointed out the greater simplicity of mechanical gear as compared with electrical, and also directed attention to its much higher efficiency. He thought it most appropriate that the solution of this important problem should have fallen to the lot of the inventor of the steam turbine. The economy of Mr. Parsons's new system could be simply expressed as the saving of one boiler in six required for ordinary reciprocating engines.

AN INSTRUCTIVE EARTH MODEL.

AT the Hotel Cecil on March 17 Mr. G. R. Gill showed a large model of the earth which, while large enough to admit of the representation of surface features in detail, can be packed into a comparatively small cabinet. A rectangular box 5 feet by 3 feet by 1 $\frac{1}{4}$ feet is wheeled easily into position, the folding lid is opened, a quadripod arrangement is raised and made rigid, a steel axis with aluminium ends is slipped into position, eighteen meridians are fitted into the ends and stay in place by their own elasticity, the three parts which go to form the equator are placed by the side of the box, and this gives the arrangement of the skeleton globe which is shown in Fig. 1.

The slope of the axis is adjustable to any angle, that of 23 $\frac{1}{2}$ ° being noted by a bell signal. The globe can be made to rotate by hand or by electric motor. The diameter of the globe is 4 feet 2 $\frac{1}{4}$ inches, which gives a scale of 1/10⁶. The meridians are made of twelve thicknesses of very thin wood cemented and riveted together.

The equator is then fixed, and from a cupboard thirty-six sections are taken and fitted into place. Fig. 2 shows the operation of inserting the last section, and shows, approximately, the height of the erected globe. The sections are of mild steel faced with *papier-mâché*, and are

sufficiently strong to resist fairly rough treatment. The surface shown in Fig. 2 is that of the earth in relief, where the scale is $1/5,100$, giving an exaggeration of twenty times. This surface shows the relief of the land, the depressions of lakes and rivers, while the limits of pack- and drift-ice in the Polar regions are ingeniously marked. From the scientific point of view it is perhaps a pity that the relief of the ocean beds has not been shown, as one of the important advantages of a globe on this scale appears to be the possibility of an adequate realisation of the gradients of the land surface, and such a conception loses more than half its value when it is limited to the subaërial parts; possibly the inventor, Mr. G. R. Gill, will be able to make sections to show the complete relief of the solid crust.

Other surface sections are available; first, political sections showing by divers colours the great world empires, the railways, the rivers, and the ocean and cable routes;

neighbouring regions; in our opinion there seems to be no end to the many practical exercises of a "heuristic" nature which pupils could be set, even to the extent of several at a time working on the one globe.

Many little devices suggest themselves at once whereby the main factors of the earth's climatic conditions might become more real; it will suffice to suggest one use of a slightly different nature; the room is darkened, the rays from the lantern are centred accurately on the model, questions of local time and sun time are discussed, and with a needle to represent a stick the shadow exercises so common in school work in the playground are repeated on the globe, with this advantage, that the graph obtained to show the sun's altitude, which took the whole of one school year to make, may now be made in a shorter period, when the work may be carried through without a break. The inventor may be congratulated on the way in which he has surmounted many mechanical difficulties, and in

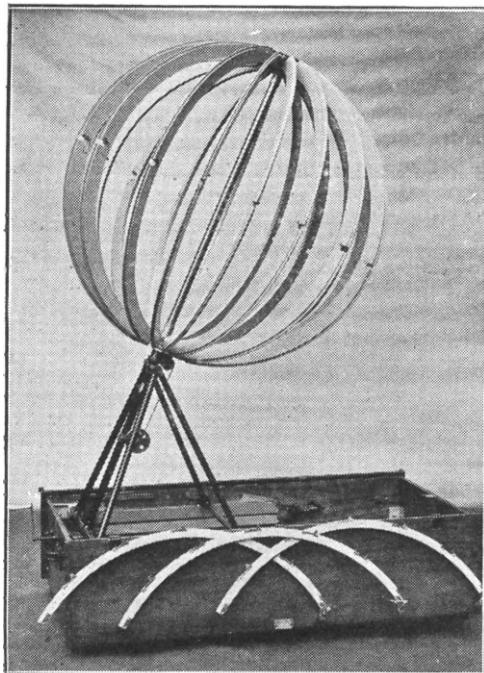


FIG. 1.—Meridians in place.



FIG. 2.—Inserting the last section.

secondly, plain sections on which the demonstrator may draw his own sketches. These sections are interchangeable, so that pupils may be tested as to their power to draw coast lines, &c. The whole globe can be set up in a few minutes, and a few seconds suffice for the changing of sections. Additional attachments are provided so that the large globe may be used to represent the sun, and a set of small balls, mounted at varying slopes, the planets; the Pole Star and Ursa Major are represented by a set of small balls to be fixed to the axis. There appears to be no difficulty in arranging the surface sections so that the upper half represents the southern hemisphere.

For purposes of measurement, and for the elucidation of "great circle sailing," schoolmasters will probably ask Mr. Gill to supply a thin steel band, graduated in degrees, which could be used to demonstrate and measure the shortest distance between two places upon the earth.

The model is sufficiently large and rigid that a youth may climb into and hide within the interior, and it is probable that for teaching purposes the possession of this globe would render the use of wall maps of the continents unnecessary for class work in geography. The teacher of geography by the methods of modern science will find this globe extremely useful, not only as his final resort in summarising the pupils' studies of a definite region, but in putting that region in precise relationship with the

which he has produced an important addition to the apparatus which may be used to teach geography scientifically.

B. C. W.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING.

THE fourth annual report of the president and treasurer of the Carnegie Foundation for the Advancement of Teaching is now available, and deals with the work of the year ending September 30, 1909. It will be remembered that, in dealing with the third report in our issue of June 3, 1909 (vol. lxxx., p. 399), Prof. J. Edgar described at length the scope and character of the foundation, and it is necessary here to deal only with points of interest in the work of the past year.

During the year the foundation granted 115 pensions amounting to 35,400^l. It is now paying 318 pensions, the cost being 93,200^l. The professors receiving these pensions are from 139 colleges, distributed over forty-three States of the Union and provinces of Canada. To the accepted list of colleges, that is, to the list the professors of which may regularly receive pensions under fixed rules as a right and not as a favour, seven colleges were admitted during the year. The governors and legislatures of twenty-six